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SUPPLEMENT TO

TWENTY-SIXTH

PROGRESS REPORT

OF

THE FIRESTONE TIRE & RUBBER COMPANY

ON

105 MM. BATTALION ANTI-TANK PROJECT

UNDER

Contract No. DA-33-019-ORD-33

ORDNANCE DEPARTMENT PROJECTS

TS4-4020—WEAPONS AND ACCESSORIES

TM1-1540—AMMUNITION

COPY No. 6

THE FIRESTONE TIRE & RUBBER COMPANY
Defense Research Division
Akron, Ohio

SEPTEMBER 1952

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SECURITY INFORMATION

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SUPPLEMENT TO

TWENTY-SIXTH

PROGRESS REPORT

OF

THE FIRESTONE TIRE & RUBBER CO.

ON

105 MM BATTALION ANTI-TANK PROJECT

Contract No.
DA-33-019-ORD-33 (Negotiated)
RAD ORDTS 1-12383

THE FIRESTONE TIRE & RUBBER CO.
Defense Research Division
Akron, Ohio

SEPTEMBER, 1952

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ABSTRACT

Three lots of serrated liners were tested. The basic design is illustrated and the variations in the three lots are detailed. The inspection data and firing data are given.

Dynamic firing tests with T138E72 projectiles incorporating DRD267 copper liners were conducted. The results are compared with similar firings with T138E57 projectiles.

Additional tests with ball bearings in double body test slugs are described.

A future program is presented.

T120 PROJECTILE

Serrated Liners

Three lots of serrated liners, all manufactured in accordance with DRD267, Fig. 1, have been tested. Two lots, #1 and #3, were manufactured by pressing flutes into standard drawn DRB398 cones. Lot #2 was made by pressing flutes into aluminum cones machined from 24S-T6 bar. The aluminum cones were annealed prior to pressing the flutes. The inspection data and the penetration data for the three lots of cones are shown in Tables I to VII, and in Figures 2, 3, 4, and 5.

DRD267 Lot #3 Copper Cones

The penetration vs spin rate behavior of these cones is shown in Fig. 2. The best average penetration, 20.8 inches, is observed at 25 rev/sec. As shown in Fig. 3, this is the same average penetration observed for the standard DRB 398 smooth cone at 0 rev/sec. The value of f (N)(Supplement to Sixteenth Progress Report) observed for this series of liners is 45.5. This is in good agreement with the general correlation shown in Fig. 7 of the Supplement to the Twenty-Second Progress Report.

An unfluted DRB398 cone may be expected to penetrate 16 inches of mild steel at 25 rev/sec (Fig. 3). At this spin rate, therefore, the DRD267 fluted cone is 5 inches (30%) better than the DRB398 smooth cone. At all spin rates between 15 rev/sec and 90 rev/sec the DRD267 cone is superior to the smooth cone.

DRD267 Lot #1 Copper Cones

The penetration vs spin rate curve for DRD267 fluted cones in T138E57 bodies, designated T138E72, is shown in Fig. 4. The best average penetration occurs, as expected, between 20 and 30 rev/sec. In this instance, however, the best penetration is 15 inches instead of 21 inches. This reduction is caused by the tee of the T138 projectile and is similar to the reduction observed with DRB398 cones at 0 rev/sec (Fig. 3). With this tee interference no advantage results from the use of the DRD267 cone at spin rates of 25 rev/sec or less, but a substantial improvement is apparent at 30 rev/sec. An effort is now being made to eliminate or at least to reduce the extent of the tee interference.

DRD267 Lot #2 Aluminum Cones

The spin rate vs penetration curve for DRD267 aluminum cones is shown in Fig. 5. The performance of smooth controls is also shown for comparison. In this case the behavior of the fluted cone is identical with that of the parent smooth cone, that is, no compensation is observed. It was not anticipated that the optimum spin rate for copper and aluminum cones with identical geometry would be the same, but some compensation was expected and the result observed is surprising. This experiment confirms that the compensation of copper cones by fluting is a complex phenomenon and that the properties of the metal play some part in the mechanism of compensation. As illustrated by the correlation for externally fluted copper cones shown in Fig. 7 of the Supplement to the Twenty-Second Progress Report, there are fluted copper cones which penetrate best at 0 rev/sec. Additional tests with aluminum cones of other designs will be required to establish whether the result observed in this experiment was a coincidence.

Dynamic Firing Tests, T138E72

Twenty T138E72 projectiles (T138E57 projectiles with DRD267 copper cones) and ten T138E57 projectiles were fired from a T137E1 rifle at Aberdeen Prov-

ing Ground. The target was homogeneous armor plate set at an obliquity of 55°. Firing data are shown in Table VIII. Ten T138E72 projectiles and ten T138E57 projectiles were fired from a tube rifled 1-200 (25 rev/sec at a muzzle velocity of 1700 ft/sec) and twenty T138E72 projectile were fired from a tube rifled 1-160 (31 rev/sec). The penetration data are as follows:

T138E57	1-200	13.2	inches H.A.
T138E72	1-200	13.0	" "
T138E72	1-160	13.3	" "

Additional tests are planned with T138 E72 projectiles having modified tees with the expectation that the penetration at both 25 and 31 rev/sec will be improved.

Double Body Projectile Tests

The performance of ball bearings in double body test slugs was described in the Supplement to the Twenty-Fifth Progress Report. The relatively poorer performance of the Fafnir #4321 bearing, compared with that of the DRC389 bearings, was attributed to the presence of a heavy brass cage. Two additional test slugs containing Fafnir #4321 bearings, as shown in Figure 6, were tested at Erie Ordnance Depot. In this case, however, the brass cages were removed and a full complement (23) of 7/16-inch steel ball bearings were used. The projectiles were fired at 1700 ft/sec (240 rev/sec) into a recovery box from a T19 rifle rifled 1-20. The measured spin rates of the "non-rotated bodies" were 23 and 24 rev/sec respectively. The recovered bearings are shown in Fig. 7. These spin rates compare favorably with those for DRC389 bearings and are much lower than was observed for the #4321 bearing with a cage (100 rev/sec).

Future Program

1. Serrated Liners

a. DRD318, 36 flutes pressed into interior surface only, .010 in. nominal flute depth, .100-inch wall thickness (42° copper cone).

b. DRD319, 45 flutes but otherwise similar to a.

c. DRD320 (a), 60 flutes but otherwise similar to a.

d. DRD320 (b), similar to c except flute depth is .020 in.

e. DRD320 (c), similar to c except flute depth is .040 in.

f. DRD321, 100 flutes but otherwise similar to a.

g. DRD78 modified by change of indexing. 16 curved flutes, internal and external, with an indexing angle of 5°. Nominal flute depth is .030 inch, wall thickness is .100 inch.

h. DRD393, 50 flutes pressed into exterior surface only, .012 in. nominal flute depth, .100-inch wall thickness (42° copper cone) Static and Dynamic Tests.

2. Double Body Projectiles

a. Firing tests with test slugs with ball bearings and tapered roller bearings to determine efficiency as a function of design.

b. Test double body projectiles with DRC389 bearings for spin rate and accuracy.

Fig. 1. Serrated Liner, DRD267.

SECRET

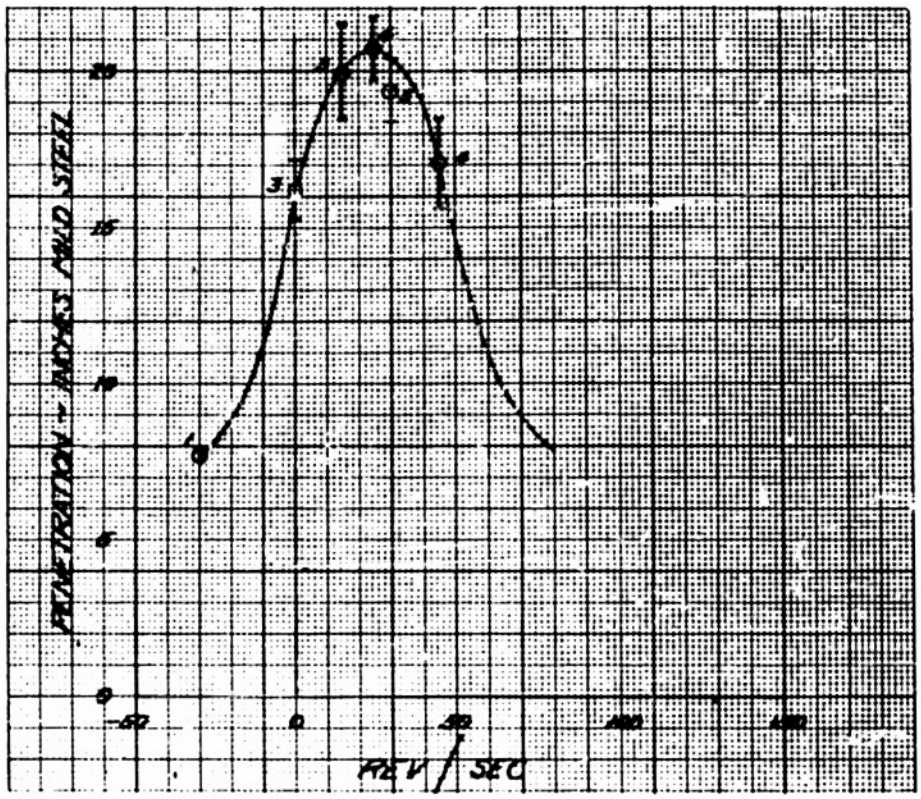

Fig. 2. Penetration Curve, DRD267, Lot #3.
(Copper Liners).

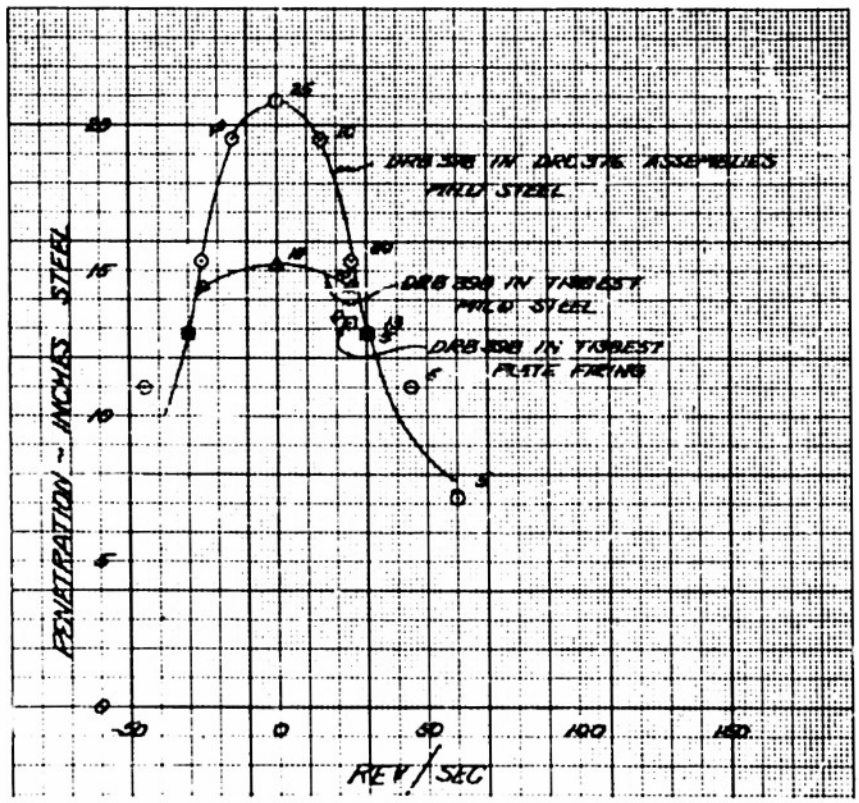

Fig. 3. Penetration Curve, DRB398 Liners.

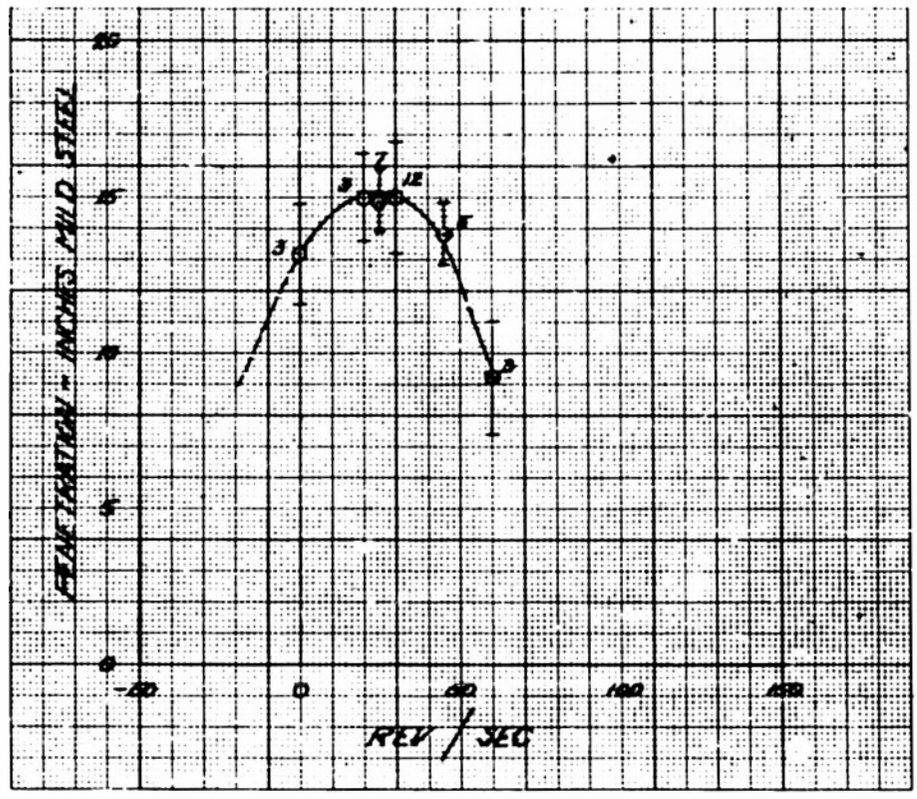

Fig. 4. Penetration Curve, DRD267, Lot #1.
(Copper Liners).

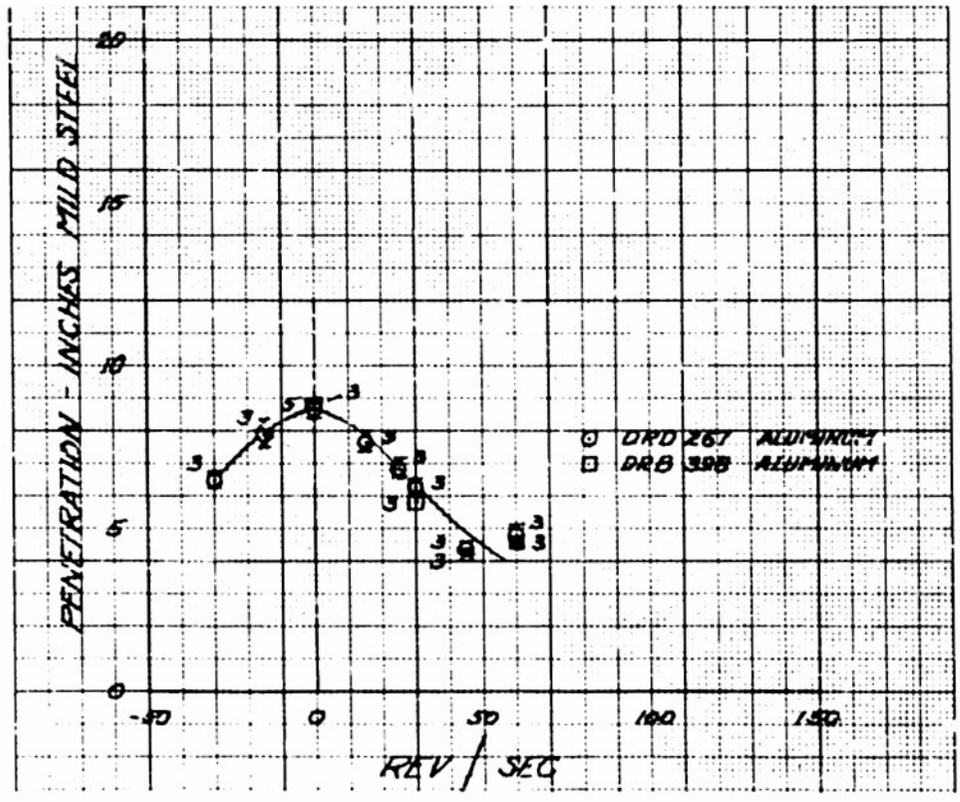

Fig. 5. Penetration Curve, DRD267, Lot #2.
(Aluminum Liners).

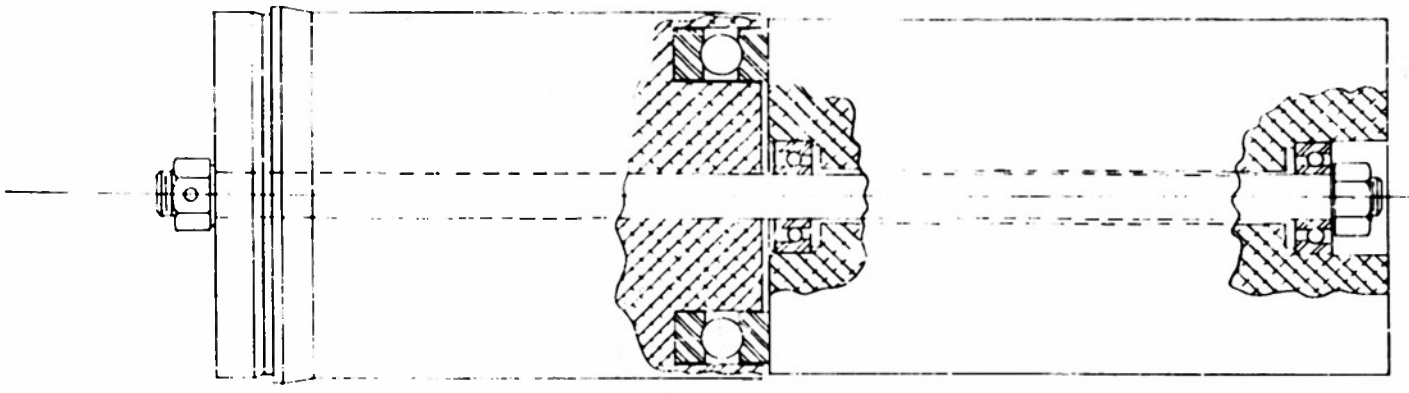

Fig. 6. Double Body Projectile.

Fig. 7. Recovered Bearings.
Fafnir #4321. 23 ½-in. Bearings.
(Without Cage).

Table I
Inspection Data For DRD267 Liners, Lot #3
(Copper)

Liner No.	Ave. Flute Depth (in.)		Std. Dev. Flute Depth (in.)		Ave. Wall Thickness (in.)		Concentricity (in.)	
	Lower Datum	Upper Datum	Lower Datum	Upper Datum	Lower Datum	Upper Datum	Lower	Upper
DRD267	.0096	.0034	--	--	.100	.100	.0030	.0030
P60-215	.0090	.0024	±.0000	±.0002	.104 - .001	.100 - .001	.0035	.0020
P60-216	.0090	.0025	±.0000	±.0000	.106 ± .002	.105 - .001	.0065	.0055
P60-217	.0088	.0022	±.0002	±.0002	.104 ± .001	.100 ± .001	.0040	.0050
P60-218	.0085	.0025	±.0000	±.0000	.104 - .001	.101 ± .002	.0085	.0075
P60-219	.0086	.0026	±.0002	±.0002	.109 ± .001	.106	.0050	.0020
P60-220	.0086	.0025	±.0002	±.0000	.106 ± .002	.100 + .001	.0080	.0100
P60-221	.0090	.0025	±.0002	±.0000	.108 ± .001	.101 ± .001	.0040	.0040
P60-222	.0090	.0025	±.0000	±.0003	.107 ± .001	.099 - .001	.0035	.0020
P60-223	.0088	.0021	±.0002	±.0002	.107 ± .002	.103 + .001	.0040	.0060
P60-224	.0085	.0022	±.0001	±.0003	.108 ± .002	.102 + .001	.0030	.0020
P60-225	.0090	.0030	±.0000	±.0000	.110 - .001	.102 ± .001	.0030	.0030
P60-226	.0085	.0025	±.0000	±.0000	.105 ± .001	.102 + .001	.0050	.0015
P60-227	.0090	.0025	±.0000	±.0000	.107 ± .002	.097 + .001	.0035	.0080
P60-228	.0090	.0025	±.0000	±.0000	.106 ± .001	.101 ± .002	.0030	.0025
P60-229	.0090	.0025	±.0000	±.0000	.108 - .001	.101 ± .001	.0020	.0040
P60-230	.0090	.0025	±.0000	±.0000	.107 ± .002	.100 ± .001	.0020	.0040
P60-231	.0084	.0025	±.0002	±.0000	.108 ± .002	.104 ± .001	.0030	.0060
P60-232	.0090	.0025	±.0000	±.0000	.105 ± .002	.104 - .001	.0060	.0040
P60-233	.0090	.0024	±.0000	±.0002	.107 ± .001	.100 + .001	.0060	.0100
P60-234	.0090	.0025	±.0000	±.0000	.110 ± .002	.104 ± .001	.0015	.0070
P60-235	.0090	.0025	±.0000	±.0000	.107 + .001	.102 ± .001	.0040	.0080
P60-236	.0090	.0025	±.0000	±.0000	.104 ± .001	.100 + .001	.0050	.0110
P60-237	.0083	.0023	±.0003	±.0003	.106 ± .001	.099 ± .001	.0020	.0030
P60-238	.0085	.0025	±.0003	±.0000	.107 ± .002	.099 ± .002	.0020	.0050
P60-239	.0090	.0025	±.0000	±.0000	.106 + .002	.100 ± .001	.0040	.0040
P60-240	.0090	.0025	±.0000	±.0000	.108 ± .002	.103 ± .001	.0030	.0020
P60-241	.0090	.0025	±.0000	±.0000	.107 + .002	.100 ± .001	.0070	.0060
P60-242	.0090	.0025	±.0000	±.0000	.105 ± .002	.097 ± .001	.0030	.0080
P60-243	.0090	.0025	±.0000	±.0000	.102 ± .002	.100 + .001	.0030	.0030
P60-244	.0085	.0025	±.0000	±.0000	.105 ± .002	.103 ± .001	.0070	.0010
P60-245	.0090	.0025	±.0000	±.0000	.103 ± .002	.097 ± .001	.0020	.0040
P60-246	.0090	.0026	±.0000	±.0002	.105 ± .001	.097 - .001	.0030	.0010
P60-247	.0089	.0026	±.0002	±.0002	.108 ± .001	.102 + .001	.0020	.0060
P60-248	.0089	.0025	±.0002	±.0000	.107 ± .002	.103 - .001	.0060	.0065
P60-249	.0090	.0025	±.0000	±.0000	.107 ± .002	.103 - .001	.0060	.0070
P60-250	.0090	.0025	±.0000	±.0000	.109 + .001	.103 - .001	.0050	.0080
P60-251	.0085	.0026	±.0000	±.0002	.108 + .001	.103 + .001	.0060	.0020
P60-252	.0090	.0025	±.0000	±.0000	.106 ± .001	.098 + .001	.0070	.0110
P60-253	.0090	.0025	±.0000	±.0000	.107 - .002	.100 - .001	.0050	.0040
P60-254	.0090	.0025	±.0000	±.0000	.109 ± .002	.100 - .001	.0090	.0065
P60-255	.0090	.0025	±.0000	±.0000	.107 ± .002	.101 + .001	.0060	.0010
P60-256	.0090	.0026	±.0000	±.0002	.106 + .001	.101 + .001	.0025	.0045
P60-257	.0090	.0025	±.0000	±.0000	.107 ± .001	.100 + .001	.0040	.0075
P60-258	.0090	.0025	±.0000	±.0000	.107 - .001	.100 - .001	.0030	.0080
P60-259	.0090	.0026	±.0000	+.0002	.107 ± .002	.102 + .001	.0050	.0130
P60-260	.0090	.0025	±.0000	±.0000	.104 ± .002	.100 + .001	.0050	.0075
P60-261	.0090	.0025	±.0000	±.0000	.106 ± .002	.099 - .001	.0025	.0060
P60-262	.0090	.0025	±.0000	±.0000	.108 + .001	.104 ± .001	.0060	.0065
P60-263	.0090	.0025	±.0000	±.0000	.104 ± .001	.098 - .001	.0060	.0080
P60-264	.0092	.0025	±.0000	±.0000	.105 - .001	.098 + .001	.0010	.0015
Average	.0089	.0025	----	----	.1065	.1009	.0042	.0053
Std. Dev.	±.0002	±.0001	----	----	±.0018	±.0022	±.0018	±.0029

Notes:
1. Lower datum is 0.484 inch above base; upper datum 3.200 inches above base.
2. The indicated measurement at each datum is the total indicator runout of the liner's outside surface relative to the register diameter. The difference between the runout at the two datum planes is an indication of the lack of perpendicularity of the register plane and the liner axis.

Table II

Penetration Data, DRD267 Liners, Lot #3 (Copper)

Static Tests – Erie Ordnance Depot

Round No.	Lb. Comp B	Rev/Sec	Penetration (inches M.S.)	Max. Spread (in.)	Std. Dev. (in.)
P60-218	2.60	-30	7.75	--	--
P60-215	2.62	0	17.18		
P60-216	2.60	"	15.81		
P60-217	2.58	"	15.56		
			Avg. 16.18	1.62	±.88
P60-228	2.56	+15	21.56		
P60-229	2.60	"	18.75		
P60-230	2.60	"	19.50		
			Avg. 19.94	2.81	±1.46
P60-222	2.58	+25	21.38		
P60-223	2.62	"	19.50		
P60-224	2.62	"	21.12		
P60-233	2.60	"	20.44		
			Avg. 20.74	2.38	±1.01
P60-219	2.60	+30	19.75		
P60-220	2.62	"	17.88		
P60-221	2.60	"	20.38		
P60-231	2.60	"	19.18		
P60-232	2.60	"	19.56		
			Avg. 19.35	2.50	±.93
P60-225	2.62	+45	15.69		
P60-226	2.60	"	15.94		
P60-227	2.62	"	18.50		
P60-234	2.62	"	18.06		
			Avg. 17.05	2.81	±1.44

Notes:

1. Components include DRC376 test assemblies with DRD267 cones No dummy base element cavities.
2. All rounds were loaded at Ravenna Arsenal, BAT Lot #16, Comp B of Holston Lot #3-126.
3. All rounds were fired at a standoff of 7.5 inches.

Table III
Inspection Data For DRD267 Liners, Lot #1
(Copper)

Liner No.	Ave Flute Depth (inches)		Std Dev Flute Depth (in.)		Average Wall Thickness (inches)		Concentricity[2]	
	Lower Datum[1]	Upper Datum	Lower Datum	Upper Datum	Lower Datum	Upper Datum	Lower	Upper
P60-56	.0099	.0030	±.0009	±.0002	.113 ± .002	.105 ± .001	.0045	.0030
P60-57	.0100	.0030	±.0092	±.0001	.109 ± .001	.101 ± .001	.0025	.0030
P60-58	.0103	.0033	±.0003	±.0102	.109 ± .001	.102 ± .001	.0020	.0030
P60-59	.0101	.0033	±.0002	±.0003	.107 ± .001	.097 ± .001	.0020	.0010
P60-60	.0103	.0034	±.0003	±.0002	.106 ± .001	.100 ± .001	.0015	.0010
P60-61	.0099	.0030	±.0009	±.0001	.107 ± .001	.096 ± .001	.0025	.0025
P60-62	.0101	.0032	±.0002	±.0002	.108 ± .001	.099 ± .002	.0030	.0050
P60-63	.0103	.0032	±.0003	±.0002	.107 ± .001	.099 ± .001	.0020	.0025
P60-64	.0101	.0031	±.0003	±.0002	.111 ± .001	.102 ± .001	.0025	.0015
P60-65	.0100	.0029	±.0001	±.0002	.107 ± .002	.098 ± .002	.0020	.0020
P60-66	.0101	.0030	±.0002	±.0001	.110 ± .001	.101 ± .001	.0010	.0050
P60-67	.0101	.0029	±.0003	±.0002	.108 ± .001	.099 ± .002	.0025	.0020
P60-68	.0100	.0030	±.0001	±.0002	.109 ± .001	.099 ± .001	.0025	.0055
P60-69	.0100	.0030	±.0002	±.0002	.109 ± .002	.099 ± .002	.0025	.0030
P60-70	.0103	.0032	±.0002	±.0003	.107 ± .002	.102 ± .001	.0025	.0030
P60-71	.0101	.0031	±.0003	±.0002	.104 ± .002	.100 ± .002	.0045	.0035
P60-72	.0099	.0032	±.0003	±.0002	.106 ± .001	.104 ± .001	.0020	.0035
P60-73	.0098	.0028	±.0004	±.0001	.106 ± .002	.100 ± .001	.0040	.0025
P60-74	.0103	.0036	±.0002	±.0005	.105 ± .001	.100 ± .001	.0020	.0040
P60-75	.0102	.0031	±.0003	±.0002	.110 ± .001	.098 ± .001	.0020	.0030
P60-76	.0099	.0031	±.0003	±.0003	.108 ± .001	.100 ± .001	.0001	.0005
P60-77	.0104	.0034	±.0002	±.0002	.106 ± .001	.102 ± .001	.0010	.0015
P60-78	.0102	.0036	±.0003	±.0003	.107 ± .001	.100 ± .001	.0020	.0010
P60-79	.0102	.0032	±.0004	±.0002	.107 ± .000	.101 ± .002	.0020	.0020
P60-80	.0099	.0030	±.0002	±.0002	.110 ± .001	.102 ± .002	.0025	.0025
P60-81	.0100	.0031	±.0002	±.0002	.109 ± .001	.100 ± .001	.0035	.0030
P60-82	.0100	.0031	±.0003	±.0004	.109 ± .002	.103 ± .001	.0030	.0010
P60-83	.0100	.0032	±.0003	±.0002	.108 ± .001	.098 ± .001	.0015	.0020
P60-84	.0101	.0033	±.0003	±.0003	.105 ± .001	.101 ± .001	.0020	.0020
P60-85	.0099	.0032	±.0004	±.0003	.106 ± .002	.101 ± .001	.0010	.0035
P60-86	.0102	.0034	±.0002	±.0002	.106 ± .001	.100 ± .001	.0030	.0030
P60-87	.0105	.0036	±.0002	±.0003	.105 ± .001	.102 ± .001	.0010	.0030
P60-88	.0094	.0034	±.0008	±.0003	.104 ± .001	.102 ± .001	.0020	.0030
P60-89	.0104	.0032	±.0002	±.0003	.107 ± .001	.100 ± .001	.0020	.0025
P60-90	.0103	.0032	±.0003	±.0002	.108 ± .001	.099 ± .001	.0025	.0030
P60-91	.0101	.0034	±.0003	±.0002	.106 ± .001	.101 ± .001	.0015	.0020
P60-92	.0100	.0029	±.0002	±.0002	.108 ± .001	.102 ± .001	.0025	.0030
P60-93	.0101	.0031	±.0002	±.0002	.106 ± .001	.099 ± .001	.0030	.0020
P60-94	.0099	.0033	±.0093	±.0004	.106 ± .001	.098 ± .001	.0035	.0030
P60-95	.0100	.0033	±.0002	±.0004	.109 ± .001	.102 ± .001	.0030	.0015
P60-96	.0100	.0030	±.0002	±.0001	.109 ± .001	.100 ± .001	.0010	.0010
P60-97	.0101	.0031	±.0002	±.0002	.108 ± .001	.100 ± .001	.0045	.0060
P60-98	.0101	.0031	±.0003	±.0002	.107 ± .001	.102 ± .001	.0040	.0030
P60-99	.0100	.0030	±.0002	±.0003	.108 ± .001	.102 ± .001	.0035	.0005
P60-100[3]	.0100	.0032	±.0002	±.0003	.106 ± .001	.100 ± .001	.0015	.0020
Average	.0101	.0032	----	----	.1076	.1004	.0024	.0026
Std. Dev.	± .0002	± .0002	----	----	± .0018	± .0018	± .0010	± .0012

Notes:
1. Lower datum is 0.300 inch above base; upper datum 3.280 inch above the base.
2. The indicated measurement at each datum is the total indicator runout of the liner's outside surface relative to the register diameter. The difference between the runout at the two datum planes is a measure of the lack of perpendicularity of the register plane and the liner axis.
3. Held for sectioning and display.

Table IV
Penetration Data, DRD267 Liners, Lot #1 (Copper)
Static Tests – Erie Ordnance Depot

Round No.	Lb Comp B	Rev/Sec	Penetration (inches M.S.)	Max. Spread (in. M.S.)	Std. Dev. (in. M.S.)
P60-58	2.28	0	14.38		
P60-61	2.28	"	11.38		
P60-62	2.28	"	13.88		
			Avg. 13.21	3.00	±1.61
P60-59	2.29	20	15.18		
P60-66	2.32	"	13.50		
P60-75	2.30	"	16.31		
			Avg. 15.00	2.81	±1.41
P60-64	2.29	25	15.38		
P60-69	2.29	"	14.69		
P60-74	2.31	"	15.31		
P60-77	2.30	"	15.06		
P60-79	2.28	"	16.25		
P60-101	2.36	"	13.94		
P60-109	2.34	"	13.25		
			Avg. 14.84	3.00	±1.00
P60-56	2.28	30	16.81		
P60-57	2.31	"	15.75		
P60-67	2.30	"	10.62		
P60-68	2.29	"	15.18		
P60-71	2.30	"	14.81		
P60-72	2.30	"	15.88		
P60-76	2.30	"	12.81		
P60-102	2.16	"	16.25		
P60-104	2.18	"	15.12		
P60-105	2.14	"	15.50		
P60-107	2.38	"	14.00		
P60-108	2.28	"	17.25		
			Avg. 15.00	6.63	±1.83
P60-60	2.28	45	13.62		
P60-73	2.29	"	13.94		
P60-78	2.27	"	13.12		
P60-103	2.18	"	15.44		
P60-106	2.24	"	13.06		
			Avg. 13.84	2.38	±.97
P60-63	2.28	60	10.62		
P60-65	2.29	"	7.18		
P60-70	2.28	"	9.88		
			Avg. 9.23	3.44	±1.81

Notes:
1. All rounds tested at E.O.D. at a standoff of 7.65 inches (Tee + .25 inch).
2. P60-56 to 79 loaded at Picatinny Arsenal PA-E-9695 with Comp B of Holston Lot 3-166. With base element cavity. P60-101 to 109 loaded at Ravenna Arsenal BAT Lot #4, with Comp B of Holston Lot 3-126. No base element cavity.
3. All rounds made up from following components:
   DRC321 body, DRC 314 tee, DRD267 cone, DRA695 tee cap, DRB129 base plug. These rounds are designated T138E72 static test assemblies.

Table V
Inspection Data For DRD267 Liners, Lot #2
(Aluminum)

Liner No.	Ave Flute Depth (in.)		Std. Dev. Flute Depth (in.)		Ave Wall Thickness (in.)		Concentricity[2] (in.)	
	Lower Datum[1]	Upper Datum	Lower Datum	Upper Datum	Lower Datum	Upper Datum	Lower	Upper
DRD267	.0086	.0034	----	----	.100	.100	.0030	.0030
P60-188	.0075	.0023	±.0004	±.0002	.107 ± .001	.104 + .001	.0015	.0055
P60-189	.0080	.0026	±.0002	±.0002	.108 + .001	.106 - .001	.0025	.0040
P60-190	.0075	.0020	±.0003	±.0000	.107 - .001	.100 + .001	.0020	.0020
P60-191	.0077	.0025	±.0002	±.0002	.109 + .001	.106 ± .001	.0015	.0020
P60-192	.0078	.0025	±.0003	±.0002	.108 + .001	.106 + .001	.0045	.0075
P60-193	.0079	.0020	±.0003	±.000	.105 ± .002	.101 - .001	.0060	.0095
P60-194	.0079	.0025	±.0003	±.0004	.108 + .001	.105 - .001	.0025	.0070
P60-195	.0079	.0023	±.0002	±.0003	.109 - .001	.102 + .001	.0040	.0040
P60-196	.0075	.0024	±.0003	±.0008	.109 +.001	.109 - .001	.0020	.0025
P60-197	.0077	.0021	±.0004	±.0002	.109 ± .001	.105 ± .001	.0045	.0040
P60-198	.0077	.0025	±.0003	±.0001	.106 ± .001	.100 + .001	.0010	.0020
P60-199	.0075	.0023	±.0003	±.0003	.108 ± .001	.107 ± .001	.0035	.0040
P60-200	.0079	.0024	±.0002	±.0002	.107 + .001	.104 - .001	.0020	.0020
P60-201	.0079	.0020	±.0003	±.0000	.108 - .001	.107 - .001	.0065	.0100
P60-202	.0079	.0023	±.0002	±.0002	.104 + .001	.101 + .001	.0015	.0025
P60-203	.0067	.0020	±.0003	±.0000	.108 + .001	.104 - .001	.0015	.0010
P60-204	.0081	.0027	±.0002	±.0003	.108 - .001	.104 + .001	.0010	.0020
P60-205	.0075	.0022	±.0004	±.0003	.107 + .001	.102 - .001	.0010	.0030
P60-206	.0078	.0025	±.0003	±.0001	.106 + .001	.101 + .001	.0035	.0035
P60-207	.0074	.0026	±.0003	±.0003	.106 ± .001	.101 - .001	.0040	.0035
P60-208	.0080	.0027	±.0002	±.0002	.108 + .001	.107 - .001	.0010	.0010
P60-209	.0076	.0024	±.0004	±.0002	.108 - .001	.105 - .001	.0025	.0045
P60-210	.0076	.0026	±.0002	±.0003	.108 + .001	.106 - .001	.0025	.0030
P60-211	.0075	.0021	±.0004	±.0002	.111 ± .001	.108 + .001	.0015	.0020
P60-212	.0076	.0021	±.0004	±.0002	.107 ± .001	.102 + .001	.0025	.0060
P60-213	.0071	.0020	±.0004	±.0001	.106 + .001	.104 - .001	.0010	.0040
P60-214[3]	.0073	.0021	±.0004	±.0002	.106 ± .001	.104 + .001	.0040	.0040
Average	.0077	.0023	----	----	.107[4]	.1037	.0026	.0039
Std. Dev.	± .0003	± .0002	----	----	±.0015	± .0025	±.0015	± .0024

Notes:
1. Lower datum is 0.900 inch above the base; upper datum 3.200 inches above base.
2. The indicated measurement at each datum is the total indicator runout of the liner's outside surface relative to the register diameter. The difference between the runout at the two datum planes is an indication of the lack of perpendicularity of the register plane and the liner axis.
3. Held for sectioning and display.

Table VI

Penetration Data, DRD267 Liners, Lot #2 (Aluminum)

Static Tests — Erie Ordnance Depot

Round No.	Lb.Comp B	Rev/Sec	Penetration (inches M.S.)	Max. Spread (in. M.S.)	Std. Dev (in. M.S.)
P60-196	2.48	-30	6.50		
P60-198	2.48	"	6.31		
P60-199	2.50	"	6.62		
			Avg. 6.48	.31	±.16
P60-207	2.54	-15	7.56		
P60-208	2.52	"	7.50		
P60-209	2.54	"	8.62		
			Avg. 7.89	.62	±.41
P60-194	2.46	0	8.31		
P60-195	2.48	"	8.56		
P60-197	2.48	"	8.75		
P60-211	2.56	"	8.69		
P60-213	2.56	"	8.94		
			Avg. 8.65	.63	±.29
P60-206	2.52	+15	7.25		
P60-210	2.56	"	7.81		
P60-212	2.56	"	7.81		
			Avg. 7.62	.56	±.32
P60-200	2.50	+25	6.44		
P60-201	2.50	"	7.12		
P60-203	2.38	"	6.88		
			Avg. 6.81	.68	±.35
P60-188	2.46	+30	5.88		
P60-189	2.48	"	6.50		
P60-191	2.48	"	5.94		
			Avg. 6.11	.62	±.34
P60-202	2.50	+45	4.44		
P60-204	2.50	"	4.38		
P60-205	2.50	"	4.31		
			Avg. 4.38	.13	±.07
P60-190	2.48	+60	4.75		
P60-192	2.46	"	5.12		
P60-193	2.50	"	4.50		
			Avg. 4.79	.62	±.32

Notes:

1. All cones were made from 24S-T6 aluminum bar, annealed, and flutes pressed in DRD267 dies.
2. All rounds were assembled in DRC376 assemblies and loaded at Ravenna Arsenal BAT Lot No. 9 with Comp B of Holston Lot No. 3-126.
3. All rounds were detonated at a standoff of 7.50 inches.

Table VII
Penetration Data
DRB398 Cones (Aluminum)

Round No.	Lbs.CompB	Rev/Sec	Penetration (inches M.S.)	Max. Spread (in. M.S.)	Std. Dev. (in. M.S.)
FS365[1]	2.44	0	8.50		
FS366[1]	2.46	"	7.62		
FS367[1]	2.42	"	8.50		
			Avg. 8.21	.88	±.51
FS356	2.44	0	9.18		
FS359	2.44	"	9.00		
FS360	2.48	"	8.06		
			Avg. 8.75	1.12	±.60
FS354	2.42	+30	5.50		
FS355	2.44	"	6.38		
FS357	2.44	"	5.94		
			Avg. 5.94	.88	±.44
FS353	2.44	+45	4.44		
FS358	2.42	"	4.12		
FS364	2.44	"	4.18		
			Avg. 4.25	.32	±.17
FS361	2.44	+60	4.44		
FS362	2.46	"	5.06		
FS363	2.48	"	4.56		
			Avg. 4.69	.62	±.33

Notes:
1. Cones were machined from aluminum bar Alloy No. 24S-T6. All but FS365, 366, 367 were annealed prior to testing.
2. All cones were assembled in DRC376 test assemblies and loaded at Ravenna Arsenal, BAT Lot No. 9 with Comp B from Holston Lot 3-126.
3. All rounds were detonated at a standoff of 7.50 inches.

Table VIII
Firing Record
Dynamic Firing of T138E72 Projectiles
Aberdeen Proving Ground

Date 8-29-52 Program Dynamic Penetration Test

PROJECTILE
Model T138E72 & T138E57
Type ____
Weight (Nominal) 17.6 lb
C.G Location ____
Bourrelet Dia (Nom.) 4.194 in.
Special Features T208 Base Element (PA-E-10091) With potted detonators & gilding metal lead cups Piece of scotch tape 4.03 wrapped around the crystal assembly

Fixed Rounds
T138E72 were Lot # PA-E-10102
T138E57 were Lot # PA-E-10103
Ambient Temp 86°F
TBI Primers
Polyethylene & Rayon Liners
3 Rubber Pads
Comp B Holston Lot 3-89

TEST GUN
Model T137E1 #4
Type 105mm Recoilless
Length of Tube 96 in.
Twist of Rifling 1-20.0
Sighting Equipment Back Sight # M62
Bore Dia. (Lands) 4.194 +.002

Nose caps had side walls of .025 in. to .032 in
Clearance from top of crystal to cap was .002 in to .018 in

Tube # 218133C
Chamber # 2283533A
Breech # 2283535
Fired from Jeep

MISCELLANEOUS DATA
Range Dynamic Penetration - 200 yds
Propellant PA30289
Type M10M2 web .055 in. Charge Wt. 8 lbs
Proof Director Mal Finnegan
Observers Wm. Brewe
Target angle was 55° from vertical
15 ft. from back of target to witness plate

Round Firing Order	Round No	Function	Proj. Weight	Powder Charge (lb)	Wind Vel. & Dir.	Chamber Pressure	Muzzle Velocity Instr.	Muzzle Velocity Actual f/s	Elev. (mils)	Penetration (in.)	Penetration Comp. Plates	Penetration Probe in Add.	Corrected Position of Hit – mils Vert.	Corrected Position of Hit – mils Horiz.	Bourrelet Diameter Front	Bourrelet Diameter Rear	Clearance Front	Clearance Rear	Observations
1	P60-91	Yes		8				1650		12.0	4	1½							
2	Q-551	Yes		8				1657		12.0	4	1½							
3	P60-96	Yes		"				1616		12.0	4	1½							
4	Q 548	No		"				1668		—	—	—							
5	P60-82	Yes		"				1668		10.5	4	0							
6	Q-546	Yes		"				1662		13.9	6	¾							
7	P60-98	Yes		"				1676		13.6	5	½							
8	Q-550	Yes		"				1679		11.5*	4	1							* Hit low and penetrated all available plate
9	P60-83	Yes		"				1670		13.1	5	0							
10	Q 544	Yes		"				1661		15.7	6	0							
11	P60-80	No		"				1668		10.8	4	⅛							
12	Q-547	Yes		"				1663		—	—	—							
13	P60-84	Yes		"				1676		13.9	5	¾							
14	Q-552	No		"				1667		12.3	4	1⅜							
15	P60 95	Yes		"				1672		—	—	—							
16	Q-543	Yes		"				1669		12.5	4	2							
17	P60-88	Yes		"				1652		15.6	6	2½							
18	Q 545	Yes		"				1661		13.1	5	0							
19	P60-90	Yes		"				1657		15.1	5	2							
20	Q-549	Yes		"				1657		13.1	5	0							
P60 Rds Are T138E72 ; Q Rounds are T138E57								1665 Avg		Average Penetration for T138E72 Rounds = 13.4 in Average Penetration for T138E57 Rounds = 13.2 in									

Target consisted of 6 - 1.5 in homogeneous armor plates inclined at 55° from the vertical

Center of Impact ____
Probable Error – Vertical ____
Probable Error – Horizontal ____

Table VIII (Cont.)
Dynamic Firing of T138E72 Projectiles

Date 8-28-52 Program Dynamic Penetration Test

PROJECTILE
Model T138
Type E72
Weight (Nominal) 17.5 lb
C.G. Location ____
Bourrelet Dia (nom.) 4.184
Special Features DRD262 Cone.
T208 base elements (PA-E-10091) with pated detonators & gilding metal lead cups except round marked with asterisk. These rounds (a) were PA-E-9699 and had gilding metal lead cups only

Fired Rounds
Lot # PA-E-10102
Ambient Temp. 78°F
TBI Primers
Polyethylene & Rayon Liners.
3 Rubber Pads.
Comp B Holston Lot 8-89

TEST GUN
Model T139E1 #4
Type 105 mm Recoilless
Length of Tube 95 in
Twist of Rifling 1-160
Sighting Equipment Boresight - M62
Bore Dia. (Lands) 4.184 +.002

Tube # 2284053
Chamber # 2283533A
Breech # 2283533
Fired from Jeep

Nose caps had side walls of .025 in. to .032 in. Clearance from top of crystal to underside of nose cap was from .002 in. to .018 in.

MISCELLANEOUS DATA
Range Ballistic Penetration - 200 yds
Propellant PA 90259
Type M10 M1 web .056 in. Charge Wt 8 lbs
Proof Director Maj Finnegan
Observers Winn, Brown

Target angle was 55° from vertical
15 ft from back of target to witness plate

Round No.	Function	Proj Weight	Powder Charge (lb)	Wind Vel. & Dir.	Chamber Pressure	Muzzle Velocity Instr.	Muzzle Velocity Actual	Elev. (mils)	Penetration (in.)	Penetration No. Comp. Plates	Penetration Probe in. Add.	Corrected Position of Hit – mils Vert.	Corrected Position of Hit – mils Horiz.	Bourrelet Diameter Front	Bourrelet Diameter Rear	Clearance Front	Clearance Rear	Observations
1 P60-81	Yes		8				1676		13.1	5	0							
2 P60-89	Yes		8				1686		13.4	5	1/4							
3 P60-97	No		8				1684		—	—	—							
4 P60-87	Yes		8				1674		11.5	4	1							
5 P60-92*	Yes		8				1672		11.3	4	3/4							
6 P60-93*	Yes		8				1678		16.0	6	1/8 in witness plate							
7 P60-91	Yes		8				1679		13.9	5	1/4							
8 P60-85	No		8				1678		—	—	—							
9 P60-99	Yes		8				1672		14.1	5	1							
10 P60-86	Yes		8				1675		13.6	6	1/2							
						Avg	1677	Avg	13.3									

Target consisted of 6-.45 in. homogeneous armor plate inclined at 55° from the vertical.

Center of Impact ____
Probable Error – Vertical ____
Probable Error – Horizontal ____

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